

Integrated Energy Master Plan  
Executive Summary  
for  
Fort Carson, Colorado

Contract No. DACA 45-78-C-0106

Prepared for  
U. S. Army Engineer District, Omaha  
Corps of Engineers  
Omaha, Nebraska

1980

78-808-4

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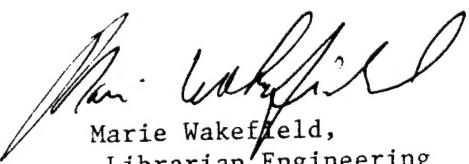


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# Integrated Energy Master Plan

## Executive Summary

for

**Fort Carson, Colorado**

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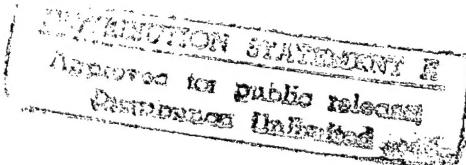
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October 22, 1980

U. S. Army Engineer District, Omaha  
Corps of Engineers  
6014 U. S. Post Office and Courthouse  
Omaha NE 68102

Fort Carson, Colorado  
Integrated Energy Master Plan  
Contract No. DACA 45-78-C-0106

Gentlemen:

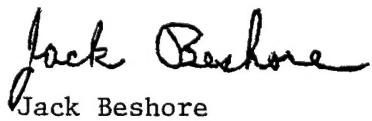
We have completed the investigation, studies and analyses to determine the best opportunities for energy conservation, solar applications and alternative energy plants.

This report contains a summary of our findings, for an energy master plan.

Sincerely,



Kenneth M. Clark, P.E.



Jack Beshore

Jack Beshore

KMC/JB/wb

Enclosures

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## I – INTRODUCTION

## EXECUTIVE SUMMARY

### PART I

#### INTRODUCTION

##### GENERAL DESCRIPTION

Fort Carson is located in south-central Colorado, south of Colorado Springs. The reservation runs 24 miles in the north-south direction and 15 miles in the east-west direction. The total area is approximately 140,000 acres. Three counties are covered by the reservation. These include El Paso, Pueblo, and Freemont counties. The fort lies between two major highways; Colorado State 115 on the west and Interstate 25 on the east. Elevations on the fort range from a high of 6,920 feet to a low of 5,120 feet.

The 4th Infantry Division (Mechanized) and several reserve units from the 6th Army District are located at Fort Carson.

##### PURPOSE OF REPORT

The purpose of this report is to provide a systematic approach for energy conservation and the most efficient use of energy sources available.

#### SCOPE OF STUDY

The scope of this study is to perform a complete energy analysis of Fort Carson. This is accomplished in the following manner:

- A. Field verify existing conditions in all buildings located on the fort.
- B. Prepare a computer model for a representative group of buildings.
- C. Evaluate all energy saving opportunities that will reduce total fort energy consumption and develop Energy Conservation Investment Program (ECIP) projects.
- D. Evaluate solar energy applications.
- E. Evaluate Energy Monitoring and Control Systems (EMCS) applications.
- F. Evaluate use of solid waste fuel.
- G. Evaluate central plant and utility distribution systems. (Steam, chilled water, electricity, gas, and potable water).

H. Evaluate economic, feasibility of installing one or more selective energy plants.

I. Evaluate economic feasibility of installing a total energy plant.

J. Evaluate economic feasibility of installing a large solar energy addition to an existing central plant.

COMPUTER PROGRAM:

The computer program DOE 1.4 (formerly CAL-ERDA) was used to arrive at all individual building energy consumption figures and most Energy Conservation Investment Program projects energy savings. This program was developed jointly by the State of California and the United States Energy Research and Development Administration.

GENERAL OVERVIEW

All information used in the preparation of a computer model and the development of ECIP is from field data or post supplied documents. All buildings in the area (except similar family housing units) were surveyed and all pertinent information recorded. This included occupancy schedules, equipment operation schedules, building architecture, type and condition of heating and cooling systems and lighting systems. ECIP projects were then developed.

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Computer models of the buildings that best represented all post area buildings were developed. The results of these computer runs provided the information to accurately assess ECIP projects and the efficient use of energy.

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## II – CONCLUSIONS AND RECOMMENDATIONS

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PART II  
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Energy Conservation

There are many opportunities for energy savings at Fort Carson. The initial costs of the projects studied ranged from a few dollars up to \$4.9 million; while some projects affected only a single building, others are applicable to nearly all permanent structures on post.

All potential energy conservation projects have been categorized into ECIP's (Energy Conservation Investment Projects) which require substantial initial capital investment with design/construct contracts, and ECO's (Energy Conservation Opportunities) which are to be performed with minimum initial cost by base personnel.

A list of viable ECIP projects is presented in Table II-1. Note that some projects overlap in scope or have similar interests, and hence the more favorable projects should be selected. For this reason, the savings and capital cost figures are not additive. However, "weighted"

totals have been indicated which will serve as reasonable estimates for implementing as many ECIP projects as possible.

Fort Carson's long-range energy goals are to reduce Btu/sf energy consumption by 20 percent from the base year FY 75 to FY 85. In FY 75, Fort Carson used  $2,727 \times 10^9$  Btu in 12,619,553 square feet including family housing. This was an energy usage of 216,093 Btu/sf. In FY 79, Fort Carson used  $2,443 \times 10^9$  Btu in 13,507,393 square feet. This is 180,864 Btu/sf. This is already a reduction of 16 percent. To complete the 20 percent reduction, Fort Carson must reduce energy by 107,918 MBtu if floor area remains the same as FY 79. This will require one of the two major ECIPs (EMCS or solid waste) or a combination of all the rest except solar (1-10 and 13). Annual savings for the combination would be \$394,202 per year. Total capital cost would be \$787,880. MBtu savings would be 102,481 MBtu per year natural gas and 6,709 MBtu per year electricity. This would result in a payback period of 2.0 years and an E/C ratio of 138. Obviously if not all the projects can be done, the combination of smaller projects should have priority.

The Solar Repowering project (Number 15 in Table II-1) is listed because solar energy proposals are not subject to ECIP requirements for approval. This project meets all applicable criteria set by the

Department of the Army, and financing has been arranged through a Department of Energy research fund.

The Solar Pool heater project (Number 16 in Table II-1) likewise meets the Army's requirements for solar project funding, and is rightfully listed as a viable proposal.

The ECO's are described in detail in Section V. They include suggested minor alterations to standing procedures and the physical plant in the interest of saving energy. For the most part, estimated dollar savings have not been prepared for these.

Other observations primarily applicable to the future must be acknowledged:

1. Passive solar energy utilization appears to be a reasonable means of minimizing energy requirements.
2. Evaporative cooling, likewise, appears to be an attractive way to save energy.
3. Changing energy rates are expected to make electricity cheaper than either natural gas or fuel oil.

While the above facts cannot be fully exploited in this report, which is essentially limited to existing facilities, they must be factored into decisions affecting future plans for the base.

Total and Selective Energy Plants

Table II-2 is a summary of life cycle costs for various alternatives. For description of the systems involved, refer to Parts III, IV, and VI, Selection of Energy Plants, Total Energy Plants, and Solar Energy Plants, respectively, of the Integrated Energy Master Plan.

Only one of the plant studies has a favorable life cycle cost. This plant steam-extraction turbine generator added to a future coal HTHW plant.

The other alternatives are affected by the very low cost of electricity (\$.018/kWh). This low rate keeps the life cycle fuel savings low and not capable of overcoming the initial capital cost and maintenance costs.

## RECOMMENDATIONS

### Energy Conservation

ECIP Projects 1 to 16, listed in Table II-1, are all recommended. As mentioned earlier, all of these cannot be implemented due to overlapping scopes and overlapping interests; it is up to the applicable authority to choose those projects which will best satisfy its needs. Projects 1 to 10 and 13 will best meet the minimum requirements of the long-range goals.

The ECO's described in Section V of this report are all recommended.

A facility-wide building reassessment is recommended, for purposes of either reaffirming or changing the function of the buildings on post, with regard to energy use. This is particularly important for the hospital complex and the confinement facility.

It is recommended that alternative designs for barracks be investigated, preferably incorporating passive solar features.

The use of evaporative cooling is recommended, to the extent the local water supply can support it. Otherwise the use of electric

refrigeration and/or absorption cooling from the proposed solid waste disposal plant is recommended.

The total energy savings proposed in Table II-1 indicates an annual savings approaching \$1,700,000. This is 29.5 percent of the current \$4,683,181 Fort expenditure for energy.

Total and Selective Energy Plants

We recommend that the steam-extraction turbine be incorporated into the future coal-fired HTHW plant.

The rest of the selective energy, total energy, solar energy and solid waste projects failed to meet the economic criteria and should not be implemented.

The low electric cost at Fort Carson does not lend itself to cogeneration. This electricity is generated almost 100 percent with coal and would appear to have relatively long-term price stability.

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## EXHIBITS

Table II-1  
TOTAL ENERGY SAVINGS\*\*

| ECP<br>I.D. | Project                 | Econ.<br>Life | Annual Energy Saved<br>(MBtu) |           | Initial Capital<br>Cost (\$) | Ben/Cost<br>Ratio | E/C<br>Ratio | Payback<br>Period |
|-------------|-------------------------|---------------|-------------------------------|-----------|------------------------------|-------------------|--------------|-------------------|
|             |                         |               | Nat. Gas                      | Elect.    |                              |                   |              |                   |
| 1. N        | Remove Street Lights    | 25            | —                             | 1,463     | 4,433                        | 1,020             | —            | 1,434             |
| 2. J        | Airflow Reduction       | 25            | 11,343                        | 1,384     | 45,596                       | 10,000            | 85.5         | 1,273             |
| 3. C        | Schedule HW Recirc.     | 10            | —                             | 1,080     | 3,272                        | 5,327             | 5.1          | 203               |
| 4. H        | Swimming Pool           | 10            | 4,465                         | 215       | 16,948                       | 8,000             | 9.9          | 585               |
| 5. L        | Night Setback*          | 15            | 27,778*                       | —         | 101,390*                     | 150,933*          | 8.8          | 194               |
| 6. A        | Destratification        | 20            | 6,997                         | (819)     | 23,057                       | 42,200            | 8.7          | 146               |
| 7. B        | Cycle HW Recirc.        | 15            | 3,958                         | 788       | 16,833                       | 38,400            | 5.4          | 124               |
| 8. D        | Strainer Cycle          | 25            | 8,348                         | 113       | 30,812                       | 68,400            | 8.2          | 113               |
| 9. G        | Flow Limiters           | 15            | 37,222                        | 865       | 138,301                      | 360,000           | 4.7          | 106               |
| 10. C       | Pt. Source Wtr. Htrs.   | 10            | —                             | 1,620     | 4,909                        | 31,525            | 1.3          | 51                |
| 11. VIII    | Solid Wst Disp — Alt 1  | 25            | 144,010                       | —         | 638,000                      | 2,430,000         | 4.0          | 59                |
| 12. VIII    | Solid Wst Disp — Alt 2* | 25            | 139,090*                      | —         | 616,000*                     | 2,610,000         | 3.7          | 53                |
| 13. I       | Boiler Reclaim          | 25            | 2,370                         | —         | 472,409                      | 4,926,000         | 1.3          | 31.6              |
| 14. VII     | EMCS                    | 15            | 106,335                       | 49,556    | 8,651                        | 72,075            | 2.3          | 33                |
| 15. IX      | Solar Repowering (B-60) | 25            | 4,055                         | —         | 282,120                      | 327,625           | 0.8          | 12                |
| 16. IX      | Solar Pool Htr (D)      | 25            | 3,425                         | —         | 12,501                       | 291,500           | 0.8          | 12                |
|             |                         |               | 332,528***                    | 56,265*** | 1,697,842***                 | 8,612,072***      |              | 23.3              |

\*Not included in totals; see explanation in text.

\*\*FY 83 Costs.

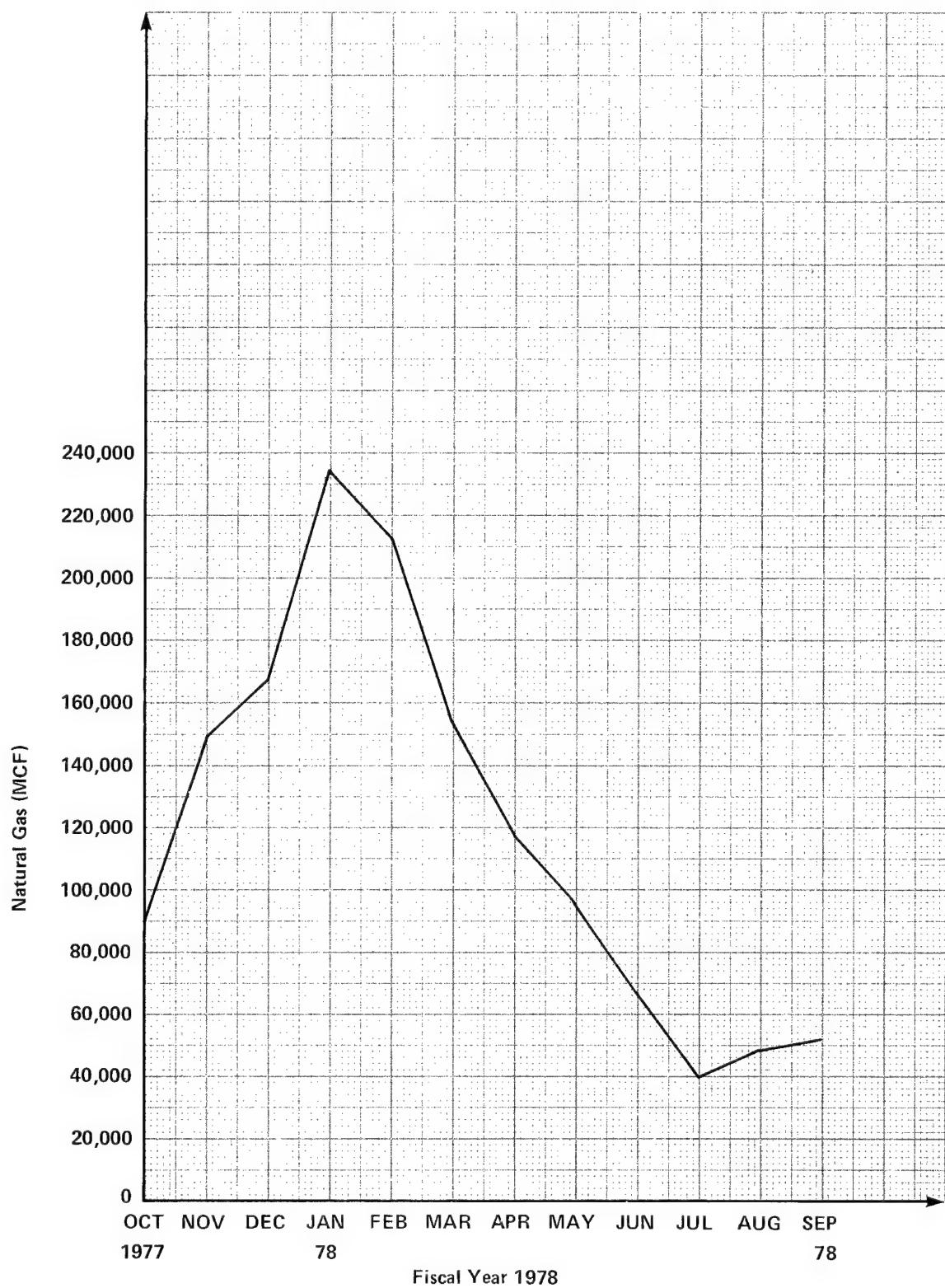
\*\*\*Totals are given to serve as a guide only; savings and capital costs are not additive, due to overlap of projects.

**Table II-2**  
**MIDPOINT OF CONSTRUCTION COSTS \$10<sup>3</sup>**

| <u>Alternate</u> | <u>Initial Cost</u> | <u>Maintenance</u> | <u>Operating</u> |                    |                    | <u>Total</u> |
|------------------|---------------------|--------------------|------------------|--------------------|--------------------|--------------|
|                  |                     | <u>Annual</u>      | <u>Coal</u>      | <u>Natural Gas</u> | <u>Electricity</u> |              |
| A                | 185.119             | 127.1              | —                | 830.69             | -675.18            | 467.73       |
| B                | 495.73              | 181.4              | —                | 2,273.35           | -2,159.37          | 791.11       |
| C                | 636.35              | 311.63             | —                | 3,179.80           | -2,523.73          | 1,604.05     |
| D                | 699.98              | 342.75             | —                | 3,041.15           | -3,492.76          | 591.12       |
| E                | 495.73              | 181.40             | —                | 1,800.97           | -2,207.40          | 270.70       |
| F                | 1,326.54            | 544.21             | —                | 7,200.28           | -8,823.80          | 247.23       |
| G                | 559.29              | 231.87             | 1,007.87         | —                  | -2,507.69          | -708.87      |
| H                | 5,282.88            | 2,913.30           | —                | 29,131.18          | -22,487.88         | 14,839.48    |
| I                | 5,969.43            | 2,448.94           | —                | 21,481.37          | -22,487.88         | 7,411.86     |

TABLE IF  
FY 1979  
ENERGY CONSUMPTION

| FUEL                  | QUANTITY       | EQUIV. BTU X 10 <sup>6</sup> | % OF TOTAL |
|-----------------------|----------------|------------------------------|------------|
| <u>NAT. GAS</u>       | 1,530,740 MCF  | 1,578,192.9                  | 64.60      |
| <u>ELECTRICITY</u>    | 69,882,400 KWH | 810,635.8                    | 33.18      |
| <u>NO. 6 FUEL OIL</u> |                |                              |            |
| <u>NO. 2 FUEL OIL</u> | 63,108 GAL     | 8,753.1                      | 0.36       |
| <u>PROPANE</u>        | 351,078 GAL    | 33,528.0                     | 1.37       |
| <u>LNG</u>            |                |                              |            |
| <u>COAL</u>           | 485 TONS       | 11,921.3                     | 0.49       |
| <u>SOLAR</u>          |                |                              |            |



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Figure 1  
FY 1978  
POST NATURAL GAS  
CONSUMPTION

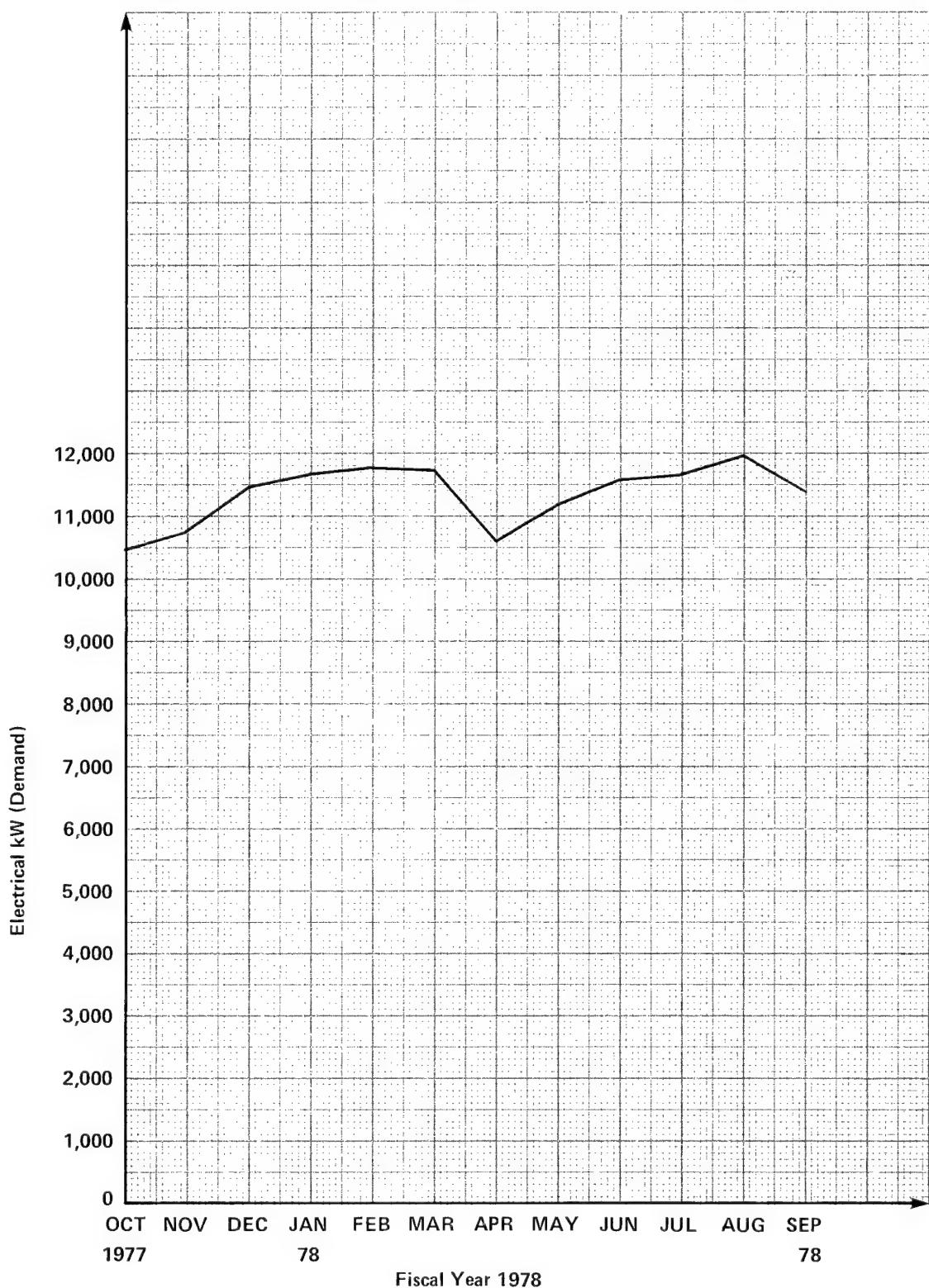
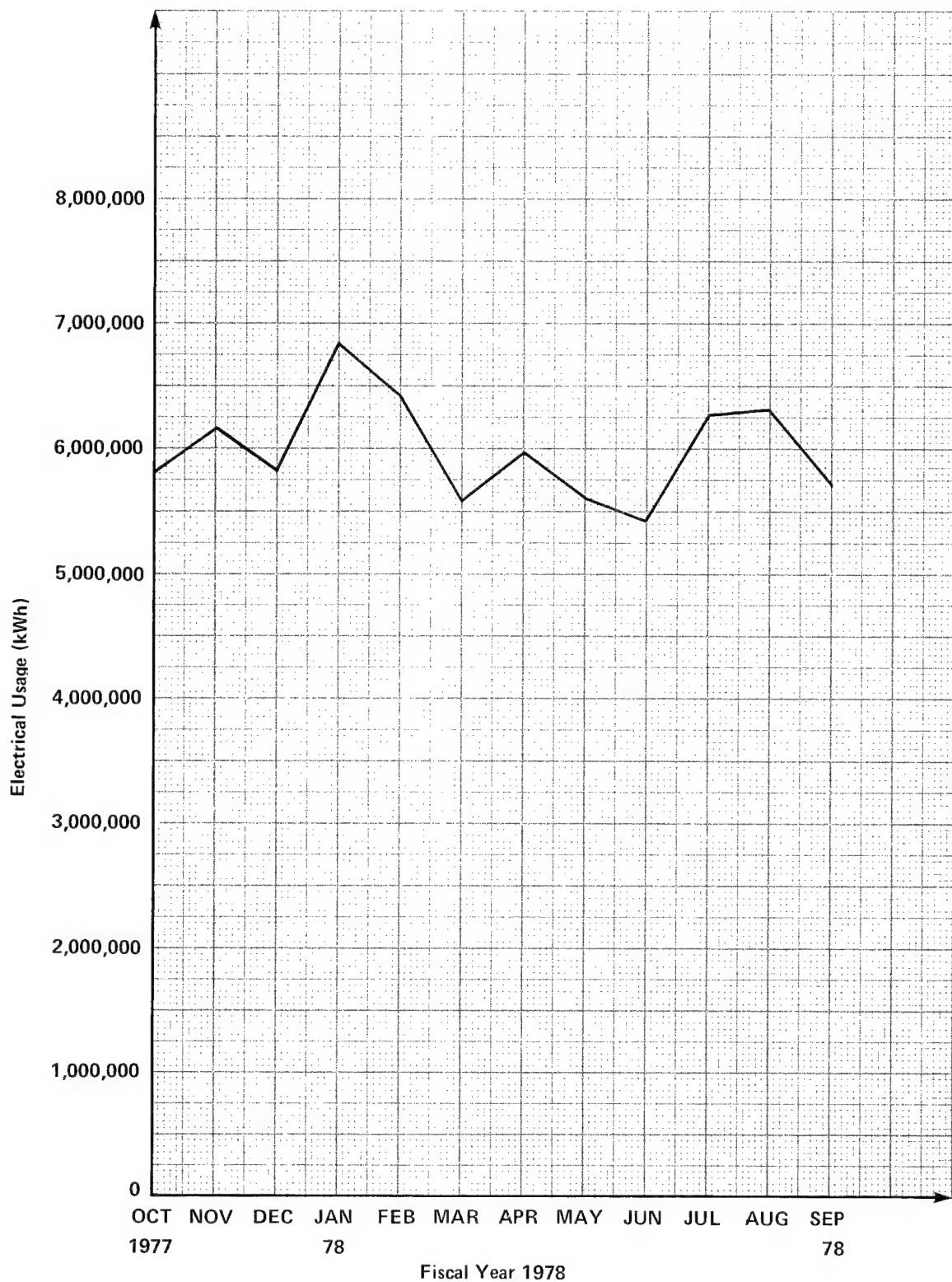
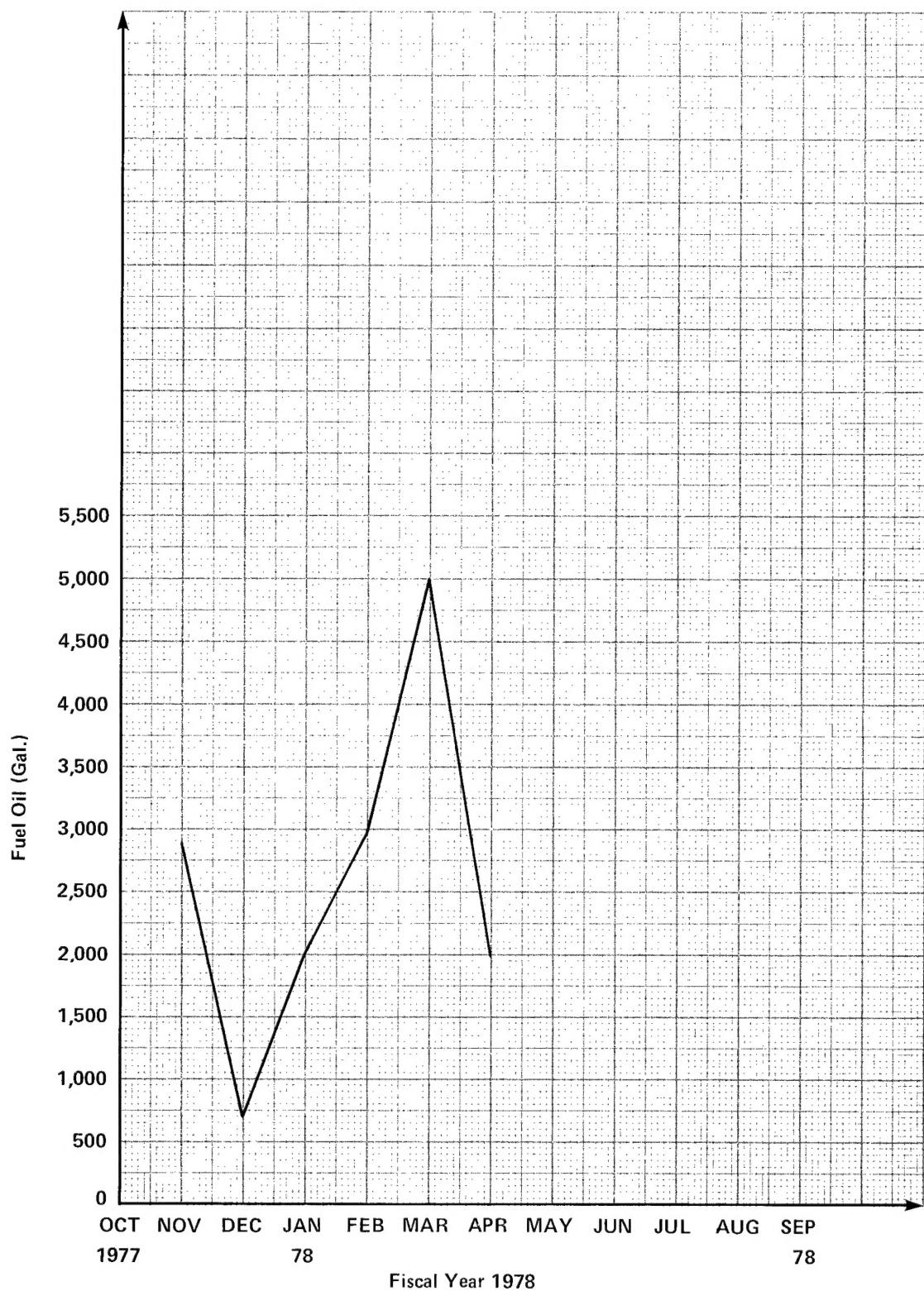


Figure 2  
FY 1978  
POST ELECTRICAL  
PEAK DEMAND



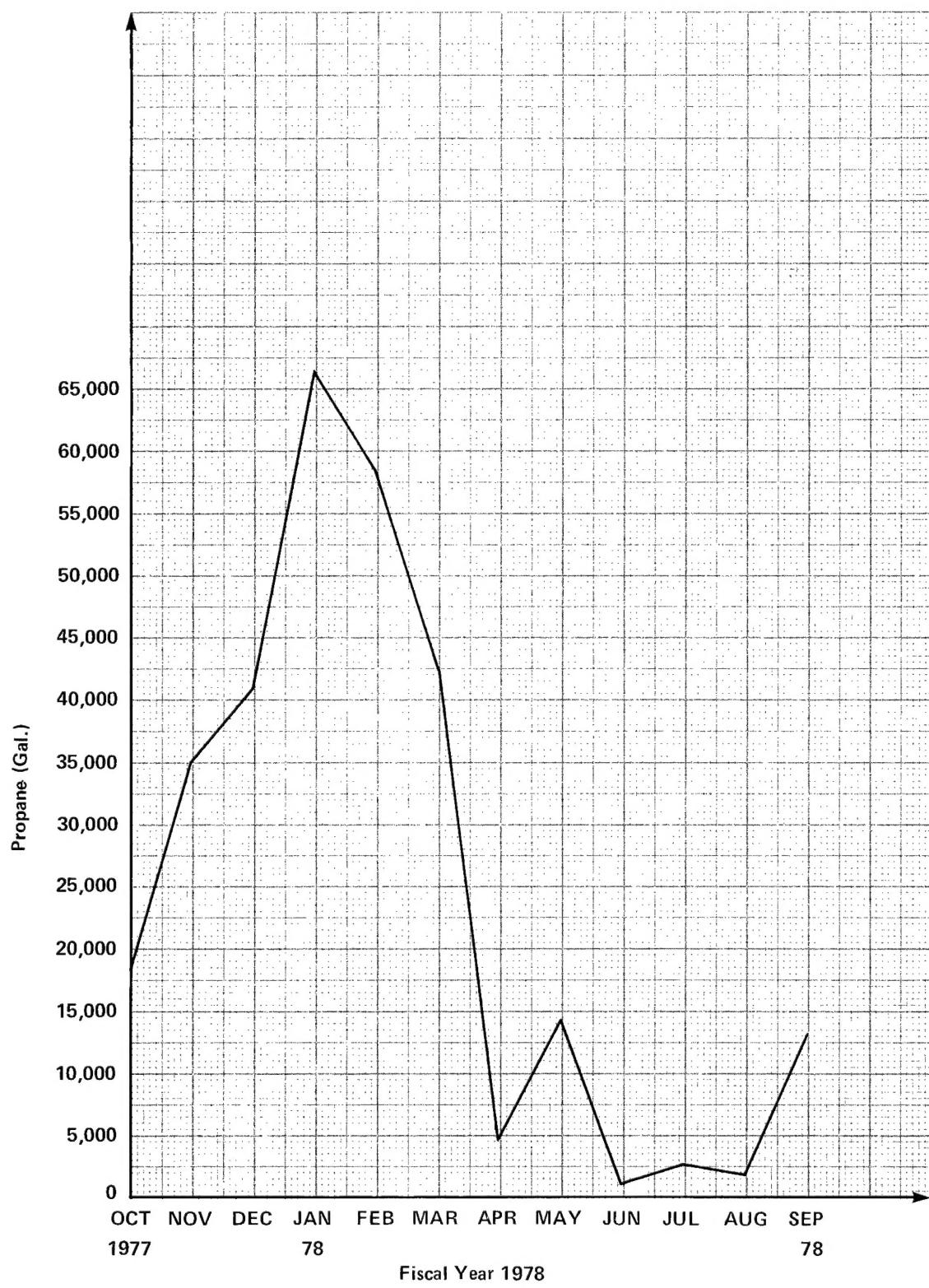
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Figure 3  
FY 1978  
POST ELECTRICAL  
CONSUMPTION



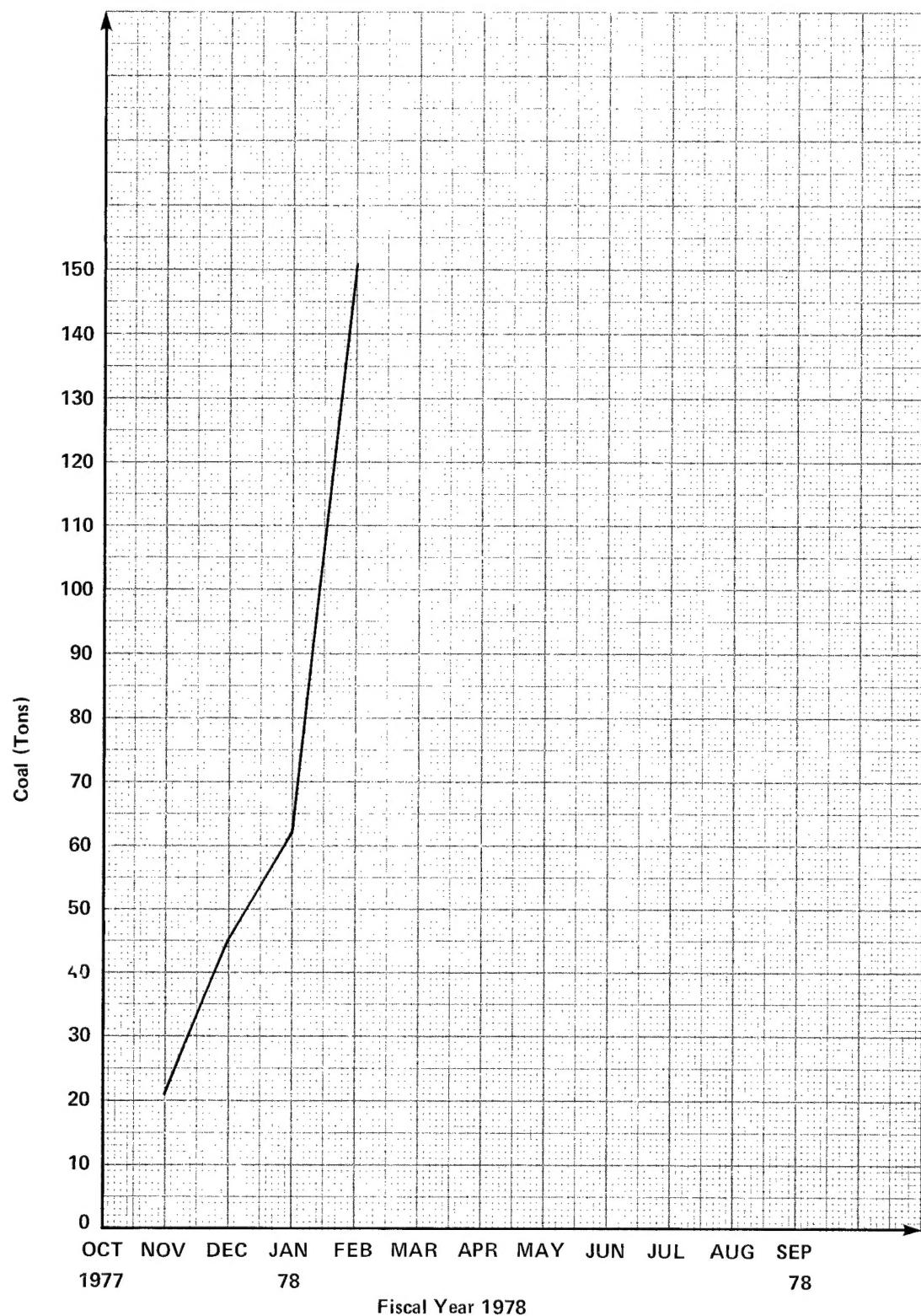
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Figure 4  
FY 1978  
POST FUEL OIL  
CONSUMPTION



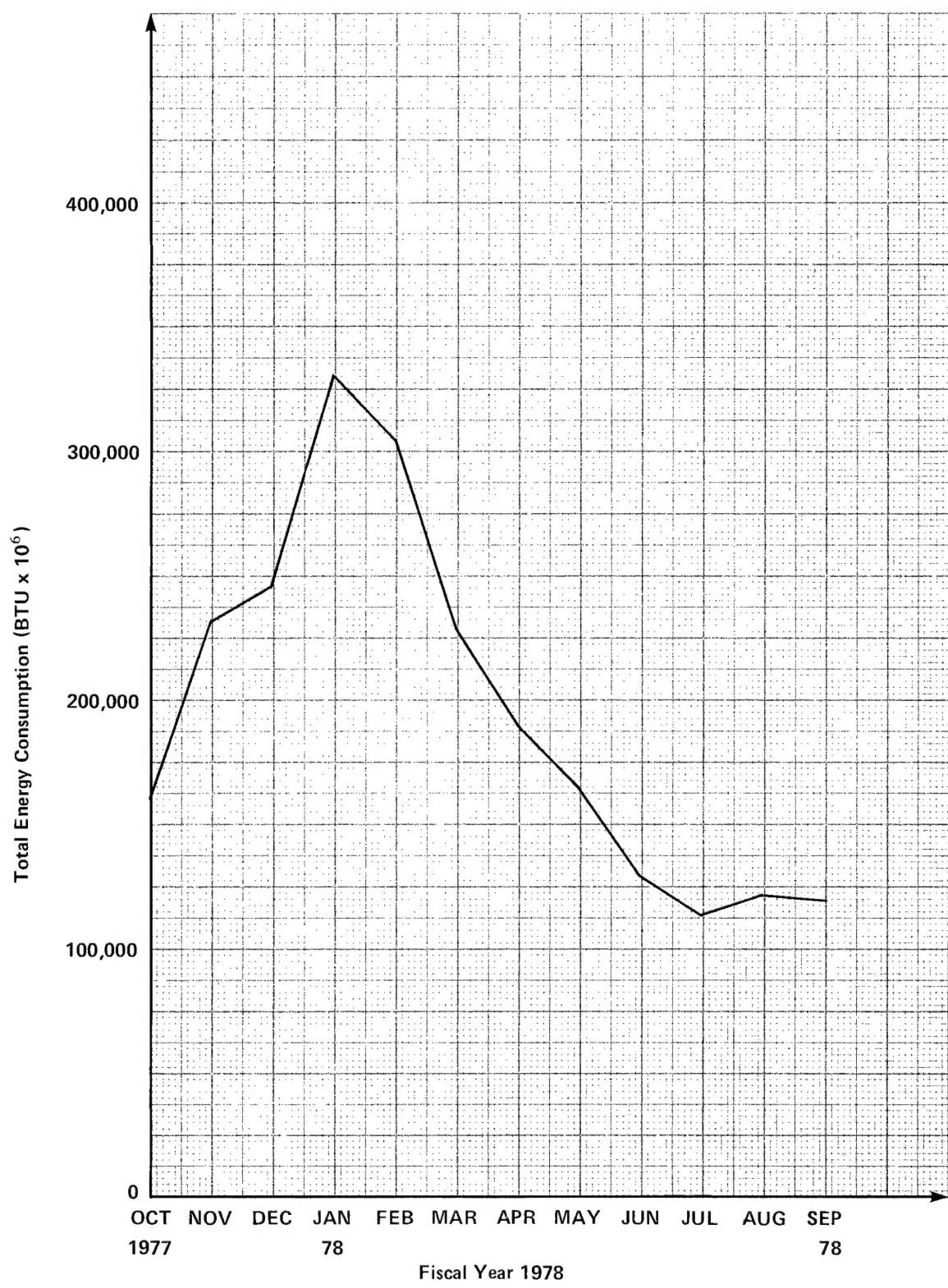
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**Figure 5**  
**FY 1978**  
**POST PROPANE**  
**CONSUMPTION**



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Figure 6  
FY 1978  
POST COAL  
CONSUMPTION



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Figure 7  
FY 1978  
TOTAL ENERGY  
CONSUMPTION